1.0 Introduction

On December 8, 1999, an explosion at the Y-12 Plant injured 11 workers, three of whom required hospitalization for burns. On December 9, 1999, Dr. David Michaels, Assistant Secretary for Environment, Safety and Health (EH), U.S. Department of Energy (DOE), appointed a Type A accident investigation board (referred to as "the Board") to investigate the accident in accordance with DOE Order 225.1A, *Accident Investigations* (see Appendix A). This report documents the results and conclusions of the accident investigation board.

1.1 Facility Description

The Y-12 Plant, located in Oak Ridge, Tennessee, encompasses 600 acres within the fenced complex, with an additional 3000 acres of buffer zone. The primary mission of the Y-12 Plant is nuclear weapons stockpile maintenance. Secondary missions include research and development, as well as management of facilities that are no longer needed for defense missions while they undergo or await decontamination and decommissioning.

Building 9201-5, also referred to as Alpha-5, was constructed in the early 1940s. It is a large (about 530,500 square foot of floor space) clay block and concrete block structure that has a high bay. The activities in Building 9201-5 are part of the Y-12 Plant depleted uranium operations (DUO) program, which encompasses processing of depleted uranium for use in stockpile maintenance. Within the DUO program, the Y-12 Arc Melt Operations Division operates various process equipment in Building 9201-5.

The accident occurred in the skull caster furnace, which is located in the Building 9201-5 high bay and is used to melt depleted uranium and niobium to form a uranium-niobium alloy needed for manufacturing nuclear weapons parts. The skull caster furnace is an inert atmosphere electric, vacuum arc-melt furnace that uses an alloy of sodium (chemical symbol Na) and potassium (chemical symbol K). The alloy (NaK) is used to cool the furnace crucible, which contains the molten metal.

Contractor activities at the Y-12 Plant are managed by the DOE Oak Ridge Operations Office (OR). The facility in which the accident occurred is under the cognizance of the Office of Defense Programs (DP). Lockheed Martin Energy Systems (LMES) is the management and operating contractor for the Y-12 Plant.

1.2 Scope, Purpose, and Methodology

The Board began its investigation on December 10, 1999, completed the onsite phase of its investigation on January 14, 2000, and submitted its report to the Assistant Secretary for Environment, Safety and Health on February 10, 2000. The scope of the Board's investigation was to review and analyze the circumstances of the accident to determine its causes. The Board also evaluated the adequacy of safety management systems and work control practices of OR and the Y-12 Plant, as they relate to the accident.

The purposes of this investigation were to determine the causes of the accident and to assist DOE in understanding lessons learned to improve safety and reduce the potential for similar accidents at the Y-12 Plant and across the DOE complex. The Board conducted its investigation using the following methodology:

- Inspecting and photographing the accident scene and individual items of evidence related to the accident
- Gathering facts through interviews, document and evidence reviews, and walkdowns of the area
- Reviewing the emergency and medical response
- Analyzing facts and identifying causal factors through events and causal factors charting and analysis, barrier analysis, and change analysis to correlate and analyze facts and identify the accident's causes (see box on page 6)

ANALYSIS METHODS

A **causal factor** is an event or condition in the accident sequence that contributes to the unwanted result. There are three types of causal factors: direct cause**,** which is the immediate event(s) or condition(s) that caused the accident; root causes, which is (are) the causal factor(s) that, if corrected, would prevent recurrence of the accident; and contributing causes, which are causal factors that collectively with other causes increase the likelihood of an accident, but that individually did not cause the accident.

Events and causal factors analysis includes charting, which depicts the logical sequence of events and conditions (causal factors) that allowed the event to occur, and the use of deductive reasoning to determine events or conditions that contributed to the accident.

Barrier analysis reviews hazards, the targets (people or objects) of the hazards, and the controls or barriers that management systems put in place to separate the hazards from the targets. Barriers may be administrative, physical, or supervisory/management.

Change analysis is a systematic approach that examines failures in barriers and controls that result from planned or unplanned changes in a system.

- Developing judgments of need for corrective actions to prevent recurrence, based on analysis of the information gathered.

1.3. Report Organization

Section 2 of this report describes the accident and the response to the accident. In Section 3, the accident investigation team presents its analysis of the Y-12 Plant processes and systems that are intended to ensure safety, such as hazard analysis, conduct of operations, procedures, worker safety processes, training, emergency response, facility design, and work planning and management systems. This analysis leads to the identification of the contributing and root causes of the accident. Section 4 presents the accident investigation board's conclusions and judgments of need, which are areas where improvements are needed to prevent recurrence of similar accidents. Appendix A provides the appointment memorandum for this Type A accident investigation. Appendix B presents the application of analysis methods and tools.